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審査請求　有　請求項の数９　ＯＬ　（全７頁）

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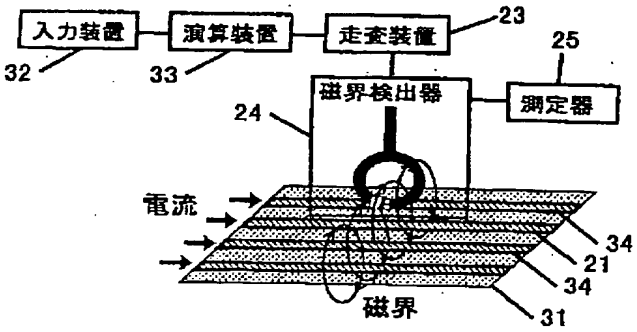
(54)【発明の名称】　磁界測定装置及び磁界検出器分解能測定装置

(57)【要約】

【課題】　高密度配線において、隣接配線の影響を抑えて一本のみの配線の電流による磁界を高分解能で測定する装置、及び方法を提供する。

【解決手段】　本発明の磁界測定装置は、複数の平行配線の一本の配線の電流による磁界を検出する磁界検出器２４と磁界測定器２５を有する磁界測定装置において、平行配線の配線ピッチ及び使用する磁界検出器２４の分解能特性を入力する入力装置３２と、配線ピッチと磁界検出器２４の分解能特性から、磁界検出器２４の配線からの高さ位置を算出する演算装置３３と、演算装置３３より得られた位置に磁界検出器２４を走査する走査装置２３とを有し、配線電流Ｉに対してグランドを対称面とした鏡像電流－Ｉの二つの電流による磁界が打ち消しあう位置が隣接配線の位置に一致するように磁界検出器２４の高さを調整することで、隣接配線の磁界の影響を抑えることを特徴とする。



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【特許請求の範囲】

【請求項１】　複数の平行配線の一本の配線の電流による磁界を検出する磁界検出器と磁界測定器を有する磁界測定装置において、

前記平行配線の配線ピッチ及び使用する前記磁界検出器の分解能特性を入力する入力装置と、

前記配線ピッチと前記磁界検出器の分解能特性から、前記磁界検出器の前記配線からの高さ位置を算出する演算装置と、

前記演算装置より得られた位置に前記磁界検出器を走査する走査装置と、を有することを特徴とする磁界測定装置。

【請求項２】　前記磁界検出器の分解能特性が、

前記配線に対して直角方向で配線面に平行な磁界強度の分布における磁界強度の最小となる前記磁界検出器の位置を前記配線面からの高さに対する分解能とし、前記配線面からの高さを変えて求めた特性を磁界検出器の高さに対する分解能特性とする請求項1記載の磁界測定装置。

【請求項３】　前記磁界検出器を走査する走査装置が、

前記配線と前記配線に対して直角方向を２軸とし、前記磁界検出器の配線面からの高さを他の１軸とする３次元を走査する走査装置を有する請求項１記載の磁界測定装置。

【請求項４】　配線の電流による磁界を検出する磁界検出器と磁界測定器を有する磁界検出器分解能測定装置において、

前記配線に対して直角方向で配線面に平行な磁界強度分布を作成する磁界強度分布作成装置と、

前記磁界強度分布の最小となる前記磁界検出器の位置を出力する磁界強度最小点検出装置と、

前記配線面からの高さを変えて求めた特性を磁界検出器の高さに対する分解能特性とする分解能特性作成装置と、

前記配線面を２軸とし、磁界検出器の高さを他の１軸とする３次元走査装置と、

前記磁界検出器の位置を検出する位置検出装置と、を有することを特徴とする磁界検出器分解能測定装置。

【請求項５】　前記磁界強度分布作成装置が、

磁界検出器の出力と、前記走査装置により走査された前記磁界検出器の位置情報を検出する位置検出装置の出力をリンクする磁界強度分布作成装置を有する請求項４記載の磁界検出器分解能測定装置。

【請求項６】　前記磁界強度最小点検出装置が、

前記磁界強度分布作成装置から、磁界強度が最小となる前記磁界検出器の位置を検出する磁界強度最小点検出装置を有する請求項４記載の磁界検出器分解能測定装置。

【請求項７】　前記分解能特性作成装置が、

前記磁界強度最小点検出装置から、磁界検出器の高さと分解能の関係を示した分解能特性を作成する分解能特性

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作成装置を有する請求項４記載の磁界検出器分解能測定装置。

【請求項８】　前記分解能特性作成装置が、

前記磁界強度最小点検出装置から、磁界検出器の高さと分解能の関係を示した分解能特性を作成し、出力する分解能特性作成装置を有する請求項４記載の磁界検出器分解能測定装置。

【請求項９】　複数の平行配線の一本の配線の電流による磁界を検出する磁界検出器と磁界測定器を有する磁界測定装置において、

前記平行配線の配線ピッチ及び使用する前記磁界検出器の分解能特性を入力する入力装置と、

前記配線ピッチと前記磁界検出器の分解能特性から、前記磁界検出器の前記配線からの高さ位置を算出する演算装置と、

前記演算装置より得られた位置に前記磁界検出器を走査し、かつ、前記配線面を２軸とし、磁界検出器の高さを他の１軸とする３次元を走査する走査装置と、

前記配線に対して直角方向で配線面に平行な磁界強度分布を作成する磁界強度分布作成装置と、

前記磁界強度分布の最小となる前記磁界検出器の位置を出力する磁界強度最小点検出装置と、

前記配線面からの高さを変えて求めた特性を磁界検出器の高さに対する分解能特性とし、前記入力装置に出力する分解能特性作成装置と、

前記磁界検出器の位置を検出する位置検出装置と、

を有することを特徴とする磁界測定装置。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、複数の配線のうち一本の配線の電流による磁界測定において、隣接配線の磁界の影響を抑えて測定することを特徴とする磁界測定装置、及び磁界検出器の分解能を測定するための磁界検出器分解能測定装置に関する。

【０００２】

【従来の技術】従来、プリント基板等の配線電流を測定するための磁界検出器として、文献「ﾒｼﾞｬｰﾒﾝﾄ ｵﾌﾞ ﾌｨｰﾙｽﾞ ｵﾌﾞ ｱﾝﾃﾅｽﾞ ｱﾝﾄﾞ ｽｷｬｯﾀｰｽﾞ(Measurement of Fields ofAntennas and Scatters)」(IEEE TRANSACTIONS ON ANTENNAS AND PROPAGATION, VOL. AP-21, NO. 4, JULY 1973 pp446-461)等に示されるセミリジッド同軸線路を加工したシールデッドループ磁界検出器を配線直下に固定し、測定された磁界よりアンペールの法則を用いて電流を求めることが一般的である。ただし、磁界検出器で得られるものは磁界に応じた電圧であり、用いる磁界検出器の出力電圧と磁界の間の変換係数をあらかじめ求めておく必要があり、文献「プリント基板近傍磁界の時間軸波形計測」電気学会論文誌Ａ（基礎・材料・共通部門誌）(VOL. 117-A, NO. 5, May 1997 pp523-530)に示されている。また、この磁界検出器は、図１１のように同

軸線路１０１をループ形状にし、同軸線路の終端１０２は短絡、または無反射終端されている。また被測定配線に最も接近する最下部は、中心導体１０３のみを残して空隙１０４を設け、その空隙１０４の終端側部分１０５で中心導体と外導体を短絡した構造である。そして、ループ面１０６を貫く磁束に応じた出力が得られる。ここで、複数の平行配線のうち一本の配線の磁界を測定する場合には、分解能を高めるために磁界検出器のループ面１０６を小さくして、測定したい配線に接近させる必要がある。従来の処理フローを図１２に示す。走査装置により固定された磁界検出器を被測定配線の直上に配置し、可能な限り該配線に接近させて近傍磁界の測定を行っていた。

【０００３】

【発明が解決しようとする課題】被測定配線を構成する基板上において、被測定配線以外の配線が存在しない場合、または他の配線が充分離れている場合には特別の配慮なく被測定配線のみの磁界を測定できるが、被測定配線のごく近傍に隣接配線が存在する場合には、被測定配線及び隣接配線による磁界が合成されて検出される。従って、被測定配線のみの磁界を測定するための条件は、磁界検出器をできる限り小型化し、被測定配線にできる限り接近させる必要がある。ところが、配線電流による磁界はある拡がりを持った分布となっているため、磁界検出器について前記条件を満たすだけでは隣接配線の影響を抑えるのは限界がある。

【０００４】本発明の目的は、高密度配線において、隣接配線の影響を抑えて一本のみの配線の電流による磁界を高分解能で測定する磁界測定装置及び磁界検出器分解能測定装置を提供することである。

【０００５】

【課題を解決するための手段】本発明の磁界測定装置は、複数の平行配線の一本の配線の電流による磁界を検出する磁界検出器と磁界測定器を有する磁界測定装置において、平行配線の配線ピッチ及び使用する磁界検出器の分解能特性を入力する入力装置と、配線ピッチと磁界検出器の分解能特性から、磁界検出器の配線からの高さ位置を算出する演算装置と、演算装置より得られた位置に磁界検出器を走査する走査装置と、を有することを特徴とする。

【０００６】更に、本発明の磁界検出器分解能測定装置は、配線の電流による磁界を検出する磁界検出器と磁界測定器を有する磁界検出器分解能測定装置において、配線に対して直角方向で配線面に平行な磁界強度分布を作成する磁界強度分布作成装置と、磁界強度分布の最小となる前記磁界検出器の位置を出力する磁界強度最小点検出装置と、により求められる。ただし、配線が充分長く、グランド面積が充分大きいとする。

＊線に対して直角方向で配線面に平行な磁界強度分布を作成する磁界強度分布作成装置と、磁界強度分布の最小となる前記磁界検出器の位置を出力する磁界強度最小点検出装置と、配線面からの高さを変えて求めた特性を磁界検出器の高さに対する分解能特性とする分解能特性作成装置と、配線面を２軸とし、磁界検出器の高さを他の１軸とする３次元走査装置と、磁界検出器の位置を検出する位置検出装置と、を有することを特徴とする。

【０００７】また、本発明の磁界測定装置は、複数の平行配線の一本の配線の電流による磁界を検出する磁界検出器と磁界測定器を有する磁界測定装置において、平行配線の配線ピッチ及び使用する磁界検出器の分解能特性を入力する入力装置と、配線ピッチと磁界検出器の分解能特性から、磁界検出器の配線からの高さ位置を算出する演算装置と、演算装置より得られた位置に磁界検出器を走査し、かつ、配線面を２軸とし、磁界検出器の高さを他の１軸とする３次元を走査する走査装置と、配線に対して直角方向で配線面に平行な磁界強度分布を作成する磁界強度分布作成装置と、磁界強度分布の最小となる前記磁界検出器の位置を出力する磁界強度最小点検出装置と、配線面からの高さを変えて求めた特性を磁界検出器の高さに対する分解能特性とし、入力装置に出力する分解能特性作成装置と、磁界検出器の位置を検出する位置検出装置と、を有することを特徴とする。

【０００８】

【発明の実施の形態】次に、本発明の基本となる考えと発明の実施の形態について、図面を参照して、詳細に説明する。

【０００９】プリント基板等の表面の配線は、主にマイクロストリップ線路であるが、マイクロストリップ線路を流れる電流による磁界を理論的に求める方法を図１３のモデルにより示す。図１３は断面図であるが、配線１１０を流れる電流Ｉに対してグランド１１１を対称面とした仮想の配線１１２を流れる鏡像電流－Ｉを仮定する。配線１１０の上方に配置された磁界検出器２４のループ面１０６の中心にある観測点１１３における検出磁界は、前記２つの電流による磁界の和で表されることは公知である。図中に示されるように、配線１１０から観測点１１３までの距離をR_1、角度をθ_1とし、鏡像電流が流れる仮想の配線１１２から観測点１１３までの距離をR_2、角度をθ_2とすると、観測点１１３での磁界強度Ｈの水平方向成分（ｘ成分）であるH_xは、

$$H_x = I\cos\theta_1 / 2\pi R_1 - I\cos\theta_2 / 2\pi R_2 \qquad (1)$$

大値で規格化している。この分布より、観測点１１３が配線１１０から高くなるほど分布の拡がりが大きくなることが分かる。また、いずれの分布も前記二つの電流による磁界が打ち消し合う位置が存在し、その位置は、次式の条件を満たす位置である。

【００１１】

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$$\cos\theta_1 / R_1 = \cos\theta_2 / R_2 \quad (2)$$

従って、この（２）式の条件を満たす時に$H_z = 0$となるが、この関係を利用して、この位置に隣接配線がある場合には、その隣接配線による磁界の影響を抑制できると考えられる。つまり、配線基板上において測定したい配線の直上に磁界検出器を配置し、図１４の磁界強度が最小となる位置が隣接配線の位置に対応するように磁界検出器の高さを調整することによって、隣接配線による磁界の影響を抑えられる。この磁界強度が最小となる配線にたいする直角方向の座標を、ここでは分解能と定義する。隣接配線の影響を抑える前記の条件は、磁界検出器のループ面１０６の大きさや形によって異なっており、使用する磁界検出器ごとに図１４の磁界強度分布を求めておく必要がある。

【００１２】

【実施例】

（実施例１）　磁界検出器の分解能特性が未知の場合

本発明の構成を図１に示す。複数の平行配線のうち一本の配線電流による磁界を測定する際に、使用する磁界検出器の分解能特性が未知の場合には、本発明の磁界検出器分解能測定装置により、あらかじめ分解能特性を求めておく必要がある。磁界検出器分解能測定装置の構成を図２に示す。単一の配線２１を持つ基板２２の上方に、３軸方向に走査可能な走査装置２３により固定した磁界検出器２４を配置し、磁界検出器２４の出力を測定器２５に接続する。また、走査装置２３より磁界検出器の位置検出装置２６を介して、測定器２５の出力とともに、磁界強度分布作成装置２７に接続し、磁界強度分布作成装置２７の出力を磁界強度最小点検出装置２８を介して分解能特性作成装置２９に接続する。

【００１３】磁界検出器分解能測定装置の測定手順は、まず磁界検出器２４を走査装置２３により一定の高さに固定し、配線に対して直角方向に配線面に平行に走査したときの磁界強度を測定する。そして磁界検出器の出力及び位置により配線に対して直角方向の磁界強度分布を作成し、その時の磁界検出器２４の高さと磁界強度が最小となる配線からの位置を検出し、その情報より使用する磁界検出器２４の分解能特性を作成する。さらに、磁界検出器２４の高さを変えて同様の処理を行う。

【００１４】例として、従来、配線電流の磁界を測定するために、一般的に用いられる図１１のセミリジッド同軸ケーブルを加工したシールデッドループ磁界検出器を用いた場合について示す。図４のように、シールデッドループ磁界検出器２４の最下部を配線２１から0.05mmの高さに固定したときの磁界強度分布を図５に示す。この分布より、磁界強度が最小となる横方向の座標は2.85mmであることが分かる。磁界検出器２４のループ面１６の高さを変えて同様に磁界強度分布を求め、磁界検出器の高さと磁界強度が最小となる配線横方向の位置、つまり分解能を関連づけた分解能特性を図６に示す。

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（２）

【００１５】（実施例２）　実施例１により磁界検出器の分解能特性が既知の場合

図１において、磁界検出器の分解能特性が実施例１により既知の場合には、複数配線の基板３１上における配線２１一本の電流による磁界を、本発明の磁界測定装置により測定できる。磁界測定装置の構成を図３に示す。複数配線の基板３１上の測定したい配線２１の上方に、３軸方向に走査可能な走査装置２３により固定した磁界検出器２４を配置し、磁界検出器２４の出力を測定器２５に接続する。また、入力装置３２から演算装置３３を介して、走査装置２３に接続する。

【００１６】磁界測定装置の測定手順は、入力装置３２に被測定基板の配線ピッチと、図６で示された使用する磁界検出器２４の分解能特性を入力する。演算装置３３では、入力された配線ピッチの値と、図５の分解能特性を参照し、両者の値が一致する磁界検出器２４の高さを導出する。走査装置２３は、測定したい配線２１の直上に磁界検出器２４を走査し、また演算装置３３により導出された磁界検出器２４の高さに磁界検出器２４を走査する。この最適な測定条件で、測定器２５では隣接配線３４の影響を最小にして測定したい配線２１の磁界を検出できる。

【００１７】例として、前記シールデッドループ磁界検出器を用いて隣接配線３４を持つ配線２１一本の電流による磁界を測定する場合を示す。配線ピッチが4.16mmの２本の配線を持つ図７の測定モデルを考え、この断面図の左側の配線２１を被測定配線として800MHz、-1dBmの正弦波で励振し、右側の配線３４を800MHz、9dBmの正弦波で励振する。ただし、磁界検出器２４と測定器（ここではパワーメータを使用）２５との間に約２０ｄＢのアンプを挿入して測定を行った。この測定モデルにおいて、左側の配線２１の電流の磁界のみを測定したい場合には、従来では、該配線２１の直上に出来るだけ接近して磁界検出器２４を配置することが考えられ、磁界検出器の高さを0.05mmとした時の磁界検出器の出力のスペクトラムを図８の実線で示す。図中の点線は、同一の高さに磁界検出器を配置し、隣接配線３４がない場合の配線２１一本の磁界検出器の出力である。この図のように、実線と点線で両者の振幅は約1.7dB異なっており、磁界検出器をただ接近させただけでは隣接配線３４の影響を受けてしまい、隣接配線３４の電流による磁界も合成されてしまうことを示している。また、今度は逆に磁界検出器の高さを2.00mmと高くした場合の磁界検出器の出力のスペクトラムを図９に示すが、両者の振幅は約5.5dB異なっており、隣接配線３４からの影響を受けている。

【００１８】そこで、実施例１によりあらかじめ分解能が分かっている磁界検出器２４を用いる場合には、分解能特性（図６）と被測定基板の配線ピッチより得られる最適測定条件となる高さに磁界検出器を配置することで

問題を解決できる。ここで、分解能特性が未知の磁界検出器を用いる場合には、実施例１に従って分解能特性を求めた後に、実施例２を行うことになる。図６によれば、使用するシールデッドループ磁界検出器は、高さが約1.14mmの時に配線ピッチ4.16mmの隣接配線３４の影響を抑制できることがわかる。そこで、磁界検出器の高さを1.14mmとした時の磁界検出器２４の出力のスペクトラムを図１０に示す。点線は、同一の高さに磁界検出器を配置し、隣接配線３４がない場合の配線２１一本の磁界検出器の出力である。この図から、両者の振幅の差は約0.5dB程度であり、前記の磁界検出器を近づけた場合（高さ0.05mm）や遠ざけた場合（高さ2.00mm）に比較し、隣接配線３４の影響が抑えられていることが分かる。

【００１９】本発明によれば、配線直角方向に磁界検出器を走査したときの磁界強度分布において、配線電流と鏡像電流による磁界の和が打ち消し合い、磁界強度が極小値をとる位置が存在するため、その位置に隣接配線がある場合には、隣接配線からの磁界の影響を抑えることができる。また、磁界検出器の高さを変化させると、前記磁界強度分布の極小値を示す位置も変化することから、配線ピッチに応じて磁界検出器の高さを変化させることで、隣接配線からの磁界の影響を抑えることができる。

【００２０】

【発明の効果】本発明の磁界測定装置及び磁界検出器分解能測定装置によれば、複数の配線において、隣接配線の影響を抑えて、一本のみの配線の電流による磁界を高分解能で測定することができると言う効果がある。

【図面の簡単な説明】

【図１】配線電流による磁界を測定するための本発明による処理フローを示す。

【図２】磁界検出器分解能測定装置の構成を示す。

【図３】磁界測定装置の構成を示す。

【図４】磁界強度分布測定の測定モデルを示す。

【図５】配線直角方向に磁界検出器を走査したときの磁界強度分布測定結果を示す。

【図６】磁界検出器の高さに対する分解能の測定結果を示す。

【図７】磁界検出器の高さをパラメータとした時の測定モデルを示す。

【図８】磁界検出器の高さを0.05mmとした時の磁界検出器出力のスペクトラムを示す。

【図９】磁界検出器の高さを2.00mmとした時の磁界検出器出力のスペクトラムを示す。

【図１０】磁界検出器の高さを1.14mmとした時の磁界検出器出力のスペクトラムを示す。

【図１１】従来のセミリジッド同軸線略を加工したシールデッドループ磁界検出器の構造を示す。

【図１２】配線電流による磁界を測定するための従来の処理フローを示す。

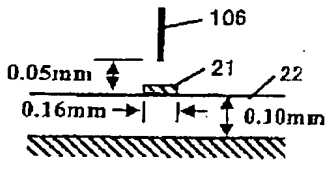
【図１３】配線直角方向の磁界強度分布を計算により求めるためのモデルを示す。

【図１４】配線直角方向に磁界検出器を走査した時の磁界強度分布の計算結果を示す。

【符号の説明】

２１	配線
２２	配線基板
２３	走査装置
２４	磁界検出器
２５	測定器
２６	磁界検出器の位置検出装置
２７	磁界強度分布作成装置
２８	磁界強度最小点検出装置
２９	分解能特性作成装置
３１	高密度配線基板
３２	入力装置
３３	演算装置
３４	隣接装置
１０１	同軸線路
１０２	同軸線路の終端
１０３	中心導体
１０４	空隙
１０５	空隙１４の終端側部分
１０６	磁界検出器のループ面
１１０	配線
１１１	配線のグランド
１１２	鏡像電流が流れる仮想配線
１１３	磁界検出器のループ面中心

【図４】



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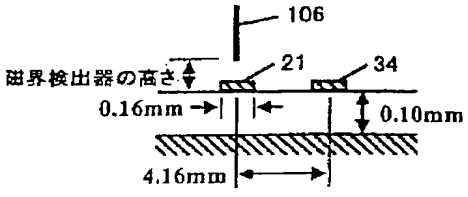

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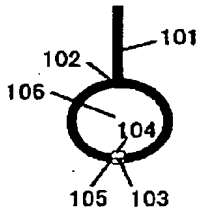

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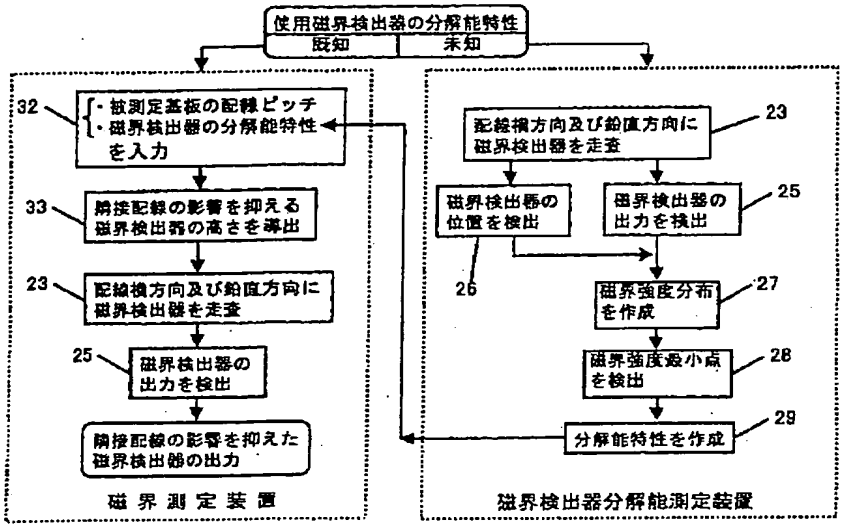

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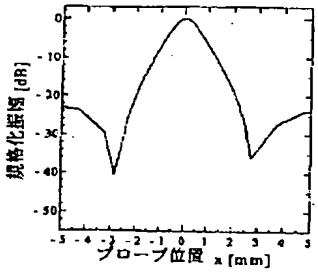

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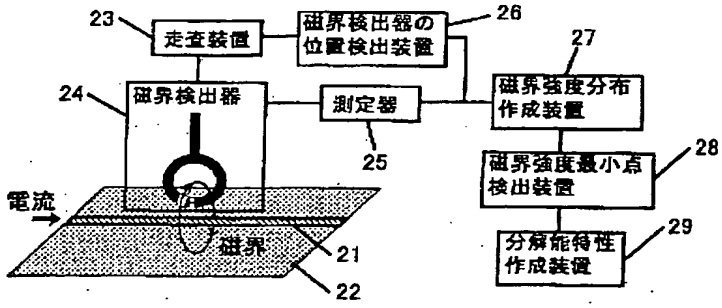

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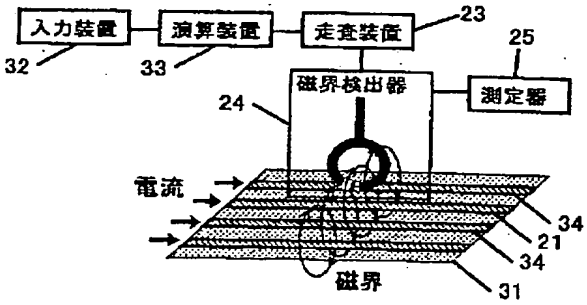

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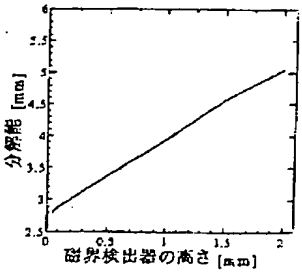

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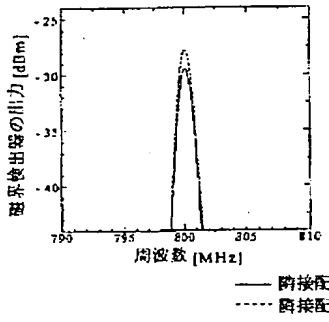

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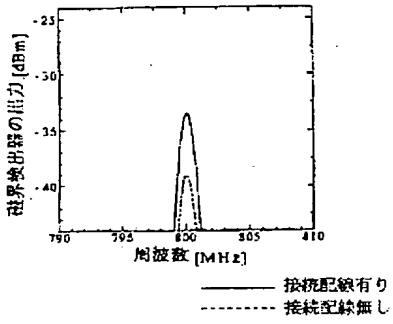

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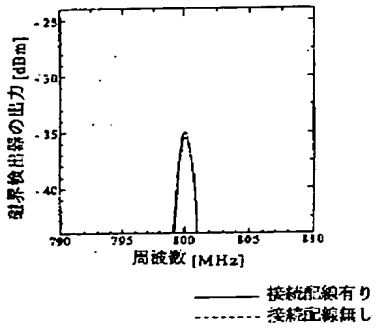

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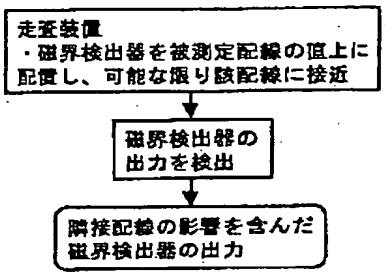

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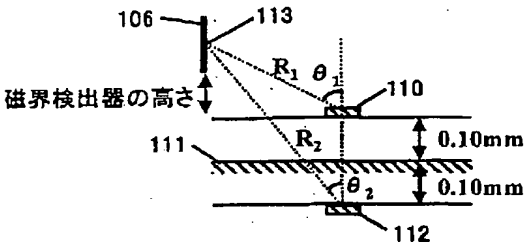

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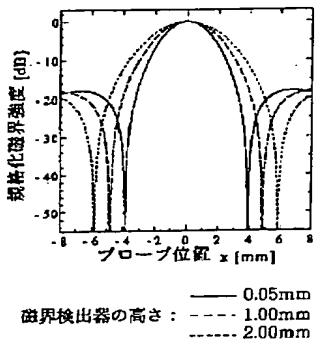

PATENT ABSTRACTS OF JAPAN

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G01R 35/00
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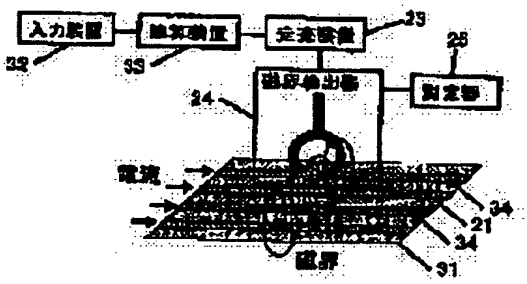
(22)Date of filing : 23.07.1997

(71)Applicant : NEC CORP
(72)Inventor : TAMAOKI NAOYA

(54) MAGNETIC FIELD MEASURING APPARATUS, AND INSTRUMENT FOR MEASURING RESOLUTION OF MAGNETIC FIELD DETECTOR

(57)Abstract:
PROBLEM TO BE SOLVED: To provide an instrument and method by which a magnetic field generated by the electric current flowing through only one electric wire can be measured with high resolution by suppressing the influences of adjacent electric wires in a high-density wiring.
SOLUTION: The magnetic field measuring apparatus using a magnetic field detector 24, which detects the magnetic field generated by the electric current flowing through one of a plurality of electric wires wired in parallel with each other and a magnetic field measuring instrument 25 is provided with an input device 32 which inputs the wiring pitch of the parallel wires and the resolution characteristic of the detector 24, an arithmetic unit 33, which calculates the height of the detector 24 from the wiring from the wiring pitch and resolution characteristic of the detector 24, and a scanning device 23, which scans the detector 24 at a position obtained from the arithmetic device 33. The influences of the magnetic fields generated by the currents flowing through adjacent electric wires are suppressed by adjusting the height of the detector 24 so that the position at which the magnetic fields generated from two currents of a wiring current I and a mirror image current −I which is symmetrical to the current I with respect to a ground offset each other may become coincident with the position of the adjacent wires.



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[Date of request for examination] 23.07.1997
[Date of sending the examiner's decision of rejection]

* NOTICES *

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CLAIMS

[Claim(s)]
[Claim 1] The magnetic field measuring device which has the magnetic field detector which detects the magnetic field by the current of the wiring of one of two or more parallel wiring characterized by providing the following, and a magnetic field measuring instrument the wiring pitch of the aforementioned parallel wiring, and the resolution of the aforementioned magnetic field detector to be used -- the input unit which inputs a property the resolution of the aforementioned wiring pitch and the aforementioned magnetic field detector -- the scanner which scans the aforementioned magnetic field detector from a property in the position obtained from the arithmetic unit which computes the height position from the aforementioned wiring of the aforementioned magnetic field detector, and the aforementioned arithmetic unit
[Claim 2] the resolution of the aforementioned magnetic field detector -- resolution [as opposed to the height of a magnetic field detector for the property which made the position of the aforementioned magnetic field detector with which a property serves as the minimum of the magnetic field strength in the distribution of magnetic field strength parallel to a wiring side in the right-angled direction to the aforementioned wiring the resolution to the height from the aforementioned wiring side, and changed and found the height from the aforementioned wiring side] -- the magnetic field measuring device according to claim 1 which makes into a property
[Claim 3] The magnetic field measuring device according to claim 1 which has the scanner which scans three dimensions to which the scanner which scans the aforementioned magnetic field detector makes the right-angled direction biaxial to the aforementioned wiring and the aforementioned wiring, and sets other one shaft as the height from the wiring side of the aforementioned magnetic field detector.
[Claim 4] the magnetic field detector which has the magnetic field detector which detects the magnetic field by the current of wiring characterized by providing the following, and a magnetic field measuring instrument -- resolution -- a measuring device The magnetic-field-strength distribution listing device which creates a magnetic-field-strength distribution parallel to a wiring side in the right-angled direction to the aforementioned wiring Magnetic-field-strength minimum-point detection equipment which outputs the position of the aforementioned magnetic field detector used as the minimum of the aforementioned magnetic-field-strength distribution resolution [as opposed to the height of a magnetic field detector for the property which changed and found the height from the aforementioned wiring side] -- the resolution made into a property -- a property listing device Position detection equipment which detects the 3-dimensional scanner which makes the aforementioned wiring side biaxial and sets other one shaft as the height of a magnetic field detector, and the position of the aforementioned magnetic field detector
[Claim 5] the magnetic field detector according to claim 4 which has the magnetic-field-strength distribution listing device to which the aforementioned magnetic-field-strength distribution listing device links the output of a magnetic field detector, and the output of the position detection equipment which detects the positional information of the aforementioned magnetic field detector scanned by the aforementioned scanner -- resolution -- a measuring device

[Claim 6] the magnetic field detector according to claim 4 with which the aforementioned magnetic-field-strength minimum-point detection equipment has [magnetic field strength] magnetic-field-strength minimum-point detection equipment which detects the position of the aforementioned magnetic field detector used as the minimum from the aforementioned magnetic-field-strength distribution listing device -- resolution -- a measuring device
[Claim 7] the above -- resolution -- the resolution the property listing device indicated the height of a magnetic field detector, and the relation of resolution to be from the aforementioned magnetic-field-strength minimum-point detection equipment -- the resolution which creates a property -- the magnetic field detector according to claim 4 which has a property listing device -- resolution -- a measuring device
[Claim 8] the above -- resolution -- the resolution the property listing device indicated the height of a magnetic field detector, and the relation of resolution to be from the aforementioned magnetic-field-strength minimum-point detection equipment -- the resolution which creates and outputs a property -- the magnetic field detector according to claim 4 which has a property listing device -- resolution -- a measuring device
[Claim 9] The magnetic field measuring device which has the magnetic field detector which detects the magnetic field by the current of the wiring of one of two or more parallel wiring characterized by providing the following, and a magnetic field measuring instrument the wiring pitch of the aforementioned parallel wiring, and the resolution of the aforementioned magnetic field detector to be used -- the input unit which inputs a property the resolution of the aforementioned wiring pitch and the aforementioned magnetic field detector -- the arithmetic unit which computes the height position from the aforementioned wiring of the aforementioned magnetic field detector from a property The scanner which scans the aforementioned magnetic field detector in the position obtained from the aforementioned arithmetic unit, and scans three dimensions which make the aforementioned wiring side biaxial and set other one shaft as the height of a magnetic field detector resolution [as opposed to / the height of a magnetic field detector / for the property changed and asked the magnetic-field-strength distribution listing device which creates a magnetic-field-strength distribution parallel to a wiring side in the right-angled direction to the aforementioned wiring, the magnetic-field-strength minimum-point detection equipment which output the position of the aforementioned magnetic field detector used as the minimum of the aforementioned magnetic-field-strength distribution, and the height from the aforementioned wiring side] -- the resolution which makes a property and outputs to an aforementioned input unit -- the position detection equipment which detects a property listing device and the position

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] the magnetic field detector for measuring the resolution of the magnetic field measuring device characterized by this invention suppressing and measuring the influence of the magnetic field of contiguity wiring in the magnetic field measurement by the current of wiring of one among two or more wiring, and a magnetic field detector -- resolution -- it is related with a measuring device
[0002]
[Description of the Prior Art] As a magnetic field detector for measuring wiring current, such as a printed circuit board, conventionally "Reference Major MENTO OBU NIA FIRUZU OBU SUKYATTAZU ANTENAZU (Measurement of Fields ofAntennas and Scatters) and -- " () [IEEE TRANSACTIONS ON ANTENNAS AND] The seal dead loop magnetic field detector into which the semi rigid coaxial track shown in PROPAGATION, VOL.AP-21, NO.4, JULY 1973 pp 446-461, etc. was processed is fixed directly under wiring. It is common to search for current using the principle of AMPERU from the measured magnetic field. However, it is the voltage according to the magnetic field which is obtained with a magnetic field detector, and it needs to ask for the output voltage of the magnetic field detector to be used, and the transform coefficient between magnetic fields beforehand, and is shown in the reference "time-axis wave measurement of magnetic field near printed circuit board" Institute of Electrical Engineers of Japan paper magazine A (base material and common section magazine) (VOL.117 and A, NO.5, May 1997 pp 523-530). Moreover, this magnetic field detector makes a coaxial track 101 a loop shape like drawing 11 , and short circuit or nonreflective termination of the termination 102 of a coaxial track is carried out. Moreover, the bottom which approaches measured wiring most is the structure which left only the central conductor 103, formed the opening 104, and connected the conductor with the central conductor too hastily outside by part for the termination flank 105 of the opening 104. And the output according to the magnetic flux which pierces through the loop side 106 is obtained. In order to raise resolution, it is necessary to make small the loop side 106 of a magnetic field detector, and to make it approach the wiring which wants to measure, in measuring the magnetic field of wiring of one among two or more parallel wiring here. The conventional processing flow is shown in drawing 12 . Have arranged the magnetic field detector fixed by the scanner right above [of measured wiring], this wiring was made to approach as much as possible, and the magnetic field was measured soon.
[0003]
[Problem(s) to be Solved by the Invention] Although the magnetic field of only measured wiring can be measured without special consideration when wiring except measured wiring does not exist on the substrate which constitutes measured wiring, or when other wiring is separated enough, when [of measured wiring] contiguity wiring exists to near very much, the magnetic field by measured wiring and contiguity wiring is compounded and detected. Therefore, the conditions for measuring the magnetic field of only measured wiring need to be miniaturized as much as possible, and need to make a

magnetic field detector approach measured wiring as much as possible. However, since the magnetic field by wiring current serves as a distribution with a certain flare, suppressing the influence of contiguity wiring has a limitation only by fulfilling the aforementioned conditions about a magnetic field detector.
[0004] the magnetic field measuring device which the purpose of this invention suppresses the influence of contiguity wiring in high-density wiring, and measures the magnetic field by the current of wiring of one by the high resolution, and a magnetic field detector -- resolution -- it is offering a measuring device

[0005]
[Means for Solving the Problem] In the magnetic field measuring device which has the magnetic field detector with which the magnetic field measuring device of this invention detects the magnetic field by the current of the wiring of one of two or more parallel wiring, and a magnetic field measuring instrument the wiring pitch of parallel wiring, and the resolution of the magnetic field detector to be used -- with the input unit which inputs a property the resolution of a wiring pitch and a magnetic field detector -- it is characterized by having from a property the arithmetic unit which computes the height position from wiring of a magnetic field detector, and the scanner which scans a magnetic field detector in the position obtained from the arithmetic unit
[0006] furthermore, the magnetic field detector of this invention -- resolution -- a measuring device In a measuring device the magnetic field detector which has the magnetic field detector which detects the magnetic field by the current of wiring, and a magnetic field measuring instrument -- resolution -- The magnetic-field-strength distribution listing device which creates a magnetic-field-strength distribution parallel to a wiring side in the right-angled direction to wiring, The magnetic-field-strength minimum-point detection equipment which outputs the position of the aforementioned magnetic field detector used as the minimum of a magnetic-field-strength distribution, resolution [as opposed to the height of a magnetic field detector for the property which changed and found the height from a wiring side] -- the resolution made into a property -- it is characterized by having a property listing device, the 3-dimensional scanner which makes a wiring side biaxial and sets other one shaft as the height of a magnetic field detector, and position detection equipment which detects the position of a magnetic field detector
[0007] Moreover, the magnetic field measuring device of this invention is set to the magnetic field measuring device which has the magnetic field detector which detects the magnetic field by the current of the wiring of one of two or more parallel wiring, and a magnetic field measuring instrument. the wiring pitch of parallel wiring, and the resolution of the magnetic field detector to be used -- with the input unit which inputs a property the resolution of a wiring pitch and a magnetic field detector -- from a property with the arithmetic unit which computes the height position from wiring of a magnetic field detector The scanner which scans a magnetic field detector in the position obtained from the arithmetic unit, and scans three dimensions which make a wiring side biaxial and set other one shaft as the height of a magnetic field detector, The magnetic-field-strength distribution listing device which creates a magnetic-field-strength distribution parallel to a wiring side in the right-angled direction to wiring, The magnetic-field-strength minimum-point detection equipment which outputs the position of the aforementioned magnetic field detector used as the minimum of a magnetic-field-strength distribution, resolution [as opposed to the height of a magnetic field detector for the property which changed and found the height from a wiring side] -- the resolution which makes a property and is outputted to an input unit -- it is characterized by having a property listing device and position detection equipment which detects the position of a magnetic field detector
[0008]
[Embodiments of the Invention] Next, the gestalt of implementation of the idea used as the foundations of this invention and invention is explained in detail with reference to a drawing.
[0009] Although wiring of front faces, such as a printed circuit board, is mainly a microstrip line, it shows how to search for theoretically the magnetic field by the current which flows a microstrip line, with the model of drawing 13 . Although drawing 13 is a cross section, mirror image current-I which

flows the wiring 112 of the imagination which made the gland 111 plane of symmetry to the current I which flows wiring 110 is assumed. The detection magnetic field in the station 113 which exists at the center of the loop side 106 of the magnetic field detector 24 arranged above wiring 110 of being expressed with the sum of the magnetic field by the two aforementioned current is well-known. it is shown all over drawing -- as -- the distance from wiring 110 to a station 113 -- R1 -- an angle -- theta 1 ** -- the distance from the wiring 112 of imagination with which it carries out and mirror image current flows to a station 113 -- R2 and an angle -- theta 2 **, if it carries out Hx which is the horizontal component (x components) of the magnetic field strength H in a station 113 Hx =Icostheta1/2piR1-Icostheta2/2piR2 (1)
It is alike and asks more. However, wiring is long enough and presupposes that grand area is sufficiently large.
[0010] Here, the calculation result which scanned the station 113 in the longitudinal direction of wiring 110 by having made the height from wiring 110 into the parameter, and asked for the magnetic-field-strength distribution is shown in drawing 14 . However, right above [of wiring 110] was set to x= 0, and magnetic field strength is standardized at maximum. The flare of a distribution is large and this distribution shows a bird clapper, so that a station 113 becomes high from wiring 110. Moreover, the position where the magnetic field by the two aforementioned current negates any distribution mutually exists, and the position is a position which fulfills the conditions of the following formula.
[0011]
costheta1/R1 =costheta2 / R2 (2)
Therefore, although it is set to Hx =0 when fulfilling the conditions of this (2) formula, when this position has contiguity wiring using this relation, it is thought that the influence of the magnetic field by the contiguity wiring can be suppressed. That is, the influence of the magnetic field by contiguity wiring can be suppressed by arranging a magnetic field detector right above [of wiring to measure on a wiring substrate], and adjusting the height of a magnetic field detector so that the position where the magnetic field strength of drawing 14 serves as the minimum may be equivalent to the position of contiguity wiring. This magnetic field strength defines the coordinate of the right-angled direction to wiring used as the minimum as resolution here. The aforementioned conditions of suppressing the influence of contiguity wiring change with the sizes and forms of the loop side 106 of a magnetic field detector, and need to ask for the magnetic-field-strength distribution of drawing 14 for every magnetic field detector to be used.
[0012]
[Example]
(Example 1) the resolution of a magnetic field detector -- when a property is strange, the composition of this invention is shown in drawing 1 the resolution of the magnetic field detector used in case the magnetic field by one wiring current is measured among two or more parallel wiring -- case a property is strange -- the magnetic field detector of this invention -- resolution -- a measuring device -- beforehand -- resolution -- it is necessary to search for a property a magnetic field detector -- resolution -- the composition of a measuring device is shown in drawing 2 The magnetic field detector 24 fixed above the substrate 22 with the single wiring 21 by the scanner 23 which can be scanned to 3 shaft orientations is arranged, and the output of the magnetic field detector 24 is connected to a measuring instrument 25. moreover, the scanner 23 -- the position detection equipment 26 of a magnetic field detector -- minding -- the output of a measuring instrument 25 -- the magnetic-field-strength distribution listing device 27 -- connecting -- the output of the magnetic-field-strength distribution listing device 27 -- magnetic-field-strength minimum-point detection equipment 28 -- minding -- resolution -- it connects with the property listing device 29
[0013] a magnetic field detector -- resolution -- the measurement procedure of a measuring device fixes the magnetic field detector 24 to fixed height by the scanner 23 first, and measures the magnetic field strength when scanning in parallel with a wiring side in the right-angled direction to wiring and the resolution of the magnetic field detector 24 which creates the magnetic-field-strength distribution of the right-angled direction to wiring with the output and position of a magnetic field detector, detects the

position from the wiring with which the height and magnetic field strength of the magnetic field detector 24 at that time serve as the minimum, and is used from the information -- a property is created Furthermore, the height of the magnetic field detector 24 is changed and same processing is performed.
[0014] As an example, in order to measure the magnetic field of wiring current conventionally, the case where the seal dead loop magnetic field detector into which the semi rigid coaxial cable of drawing 11 generally used was processed is used is shown. Like drawing 4 , the magnetic-field-strength distribution when fixing the bottom of the seal dead loop magnetic field detector 24 to a height of 0.05mm from wiring 21 is shown in drawing 5 . It turns out that the coordinate of the longitudinal direction to which magnetic field strength serves as the minimum from this distribution is 2.85mm. the resolution which associated the position of a wiring longitudinal direction where the height of the loop side 16 of the magnetic field detector 24 is changed, it asks for a magnetic-field-strength distribution similarly, and the height and magnetic field strength of a magnetic field detector serve as the minimum, i.e., resolution, -- a property is shown in drawing 6
[0015] (Example 2) an example 1 -- the resolution of a magnetic field detector -- the case where a property is known -- drawing 1 -- setting -- the resolution of a magnetic field detector -- the wiring 21 on the substrate 31 of two or more wiring of a property to a known case by the example 1 -- the magnetic field by one current can be measured by the magnetic field measuring device of this invention The composition of a magnetic field measuring device is shown in drawing 3 . The magnetic field detector 24 fixed above the wiring 21 which wants to measure on [two or more] the substrate 31 of wiring by the scanner 23 which can be scanned to 3 shaft orientations is arranged, and the output of the magnetic field detector 24 is connected to a measuring instrument 25. Moreover, it connects with a scanner 23 through an arithmetic unit 33 from an input unit 32.
[0016] the resolution of the magnetic field detector 24 with which the measurement procedure of a magnetic field measuring device was indicated to be the wiring pitch of a measurement board-ed to the input unit 32 by drawing 6 and to be used -- a property is inputted the value of the wiring pitch inputted in the arithmetic unit 33, and the resolution of drawing 5 -- with reference to a property, the height of the magnetic field detector 24 whose value of both corresponds is derived A scanner 23 scans the magnetic field detector 24 in the height of the magnetic field detector 24 which scanned the magnetic field detector 24 right above [of the wiring 21 to measure], and was drawn with the arithmetic unit 33. The magnetic field of the wiring 21 which wants to make [wiring] influence of the contiguity wiring 34 into the minimum, and to measure it in a measuring instrument 25 on this optimal measurement condition is detectable.
[0017] the wiring 21 which has the contiguity wiring 34, using the aforementioned seal dead loop magnetic field detector as an example -- the case where the magnetic field by one current is measured is shown A wiring pitch considers the measurement model with the wiring of two which is 4.16mm of drawing 7 , excites by 800MHz a - 1dBm sine wave by considering wiring 21 on the left-hand side of this cross section as measured wiring, and excites the right-hand side wiring 34 by the sine wave (800MHz and 9dBm). However, it measured by inserting about 20dB amplifier between the magnetic field detector 24 and a measuring instrument (here, a power meter being used) 25. In this measurement model, by the former, it is possible to approach right above [of this wiring 21] as much as possible, and to arrange the magnetic field detector 24 to **** which wants to measure only the magnetic field of the current of the left-hand side wiring 21, and the solid line of drawing 8 shows the spectrum of the output of the magnetic field detector when setting the height of a magnetic field detector to 0.05mm to it. the wiring 21 in case the dotted line in drawing arranges a magnetic field detector in the same height and there is no contiguity wiring 34 -- it is the output of one magnetic field detector Like this drawing, about 1.7dB of both amplitude differs by the solid line and the dotted line, it is influenced of the contiguity wiring 34 only by making a magnetic field detector merely approach, and it is shown that the magnetic field by the current of the contiguity wiring 34 will also be compounded. Moreover, although the spectrum of the output of the magnetic field detector at the time of making the height of a magnetic field detector high with 2.00mm conversely is shown in drawing 9 , about 5.5dB of both amplitude differs, and they is influenced from the contiguity wiring 34 this time.

[0018] then -- the case where the magnetic field detector 24 which resolution understands beforehand according to the example 1 is used -- resolution -- a problem is solvable by arranging a magnetic field detector in the height used as a property (drawing 6) and the optimal measurement conditions acquired from the wiring pitch of a measurement board-ed here -- resolution -- the case where a magnetic field detector with a strange property is used -- an example 1 -- following -- resolution -- an example 2 will be performed after searching for a property According to drawing 6 , it turns out that the seal dead loop magnetic field detector to be used can suppress the influence of the contiguity wiring 34 of wiring pitch 4.16mm when height is about 1.14mm. Then, the spectrum of the output of the magnetic field detector 24 when setting the height of a magnetic field detector to 1.14mm is shown in drawing 10 . the wiring 21 in case a dotted line arranges a magnetic field detector in the same height and there is no contiguity wiring 34 -- it is the output of one magnetic field detector The difference of both amplitude is about about 0.5dB, and this drawing shows that the influence of the contiguity wiring 34 is suppressed as compared with the case (a height of 2.00mm) where it keeps away when the aforementioned magnetic field detector is brought close (a height of 0.05mm).
[0019] According to this invention, in the magnetic-field-strength distribution when scanning a magnetic field detector in the wiring right-angled direction, the sum of the magnetic field by wiring current and mirror image current negates each other, and since the position where magnetic field strength takes the minimal value exists, when the position has contiguity wiring, the influence of the magnetic field from contiguity wiring can be suppressed. Moreover, if the height of a magnetic field detector is changed, since the position which shows the minimal value of the aforementioned magnetic-field-strength distribution will also change, the influence of the magnetic field from contiguity wiring can be suppressed by changing the height of a magnetic field detector according to a wiring pitch.
[0020]
[Effect of the Invention] the magnetic field measuring device of this invention, and a magnetic field detector -- resolution -- according to the measuring device, in two or more wiring, the influence of contiguity wiring is suppressed and there is an effect referred to as being able to measure the magnetic field by the current of wiring of one by the high resolution

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[Translation done.]